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EXPLORATION

OF THE

SURFACE FAUNA OF THE GULF STREAM

UNDER THE AUSPICES OF THE COAST SURVEY.

BY ALEXANDER AGASSIZ.

III. PART I.

The Porpitidæ and Velellidæ. By ALEXANDER AGASSIZ.

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WHILE at the Tortugas † examining the structure of the coral reefs, I took advantage of my opportunities to study the surface Fauna of the Gulf Stream, and when not otherwise occupied devoted the time I could spare to complete the notes and drawings I had accumulated regarding Porpita and Velella under less favorable circumstances at other points of Florida, at Newport, and on board of the "Blake." These notes are now published, as giving the principal points on the Natural History of a small and limited group of Oceanic Hydroids, interesting from their affinities, on the one side, to the Tubularians, with which Vogt, Kölliker, and Agassiz were inclined to associate them, and, on the other, with the Siphonophoræ proper, with which, as

* MR. C. O. WHITMAN was sent to Key West this spring in hopes of obtaining the material necessary to complete this memoir, and at the same time to investigate anew the whole subject of the structure and functions of the so-called yellow cells. Although Mr. Whitman spent six weeks at Key West, he was unable to accomplish the object of his trip, not a single Velella appearing in the harbor of Key West during the whole of his visit. I have therefore thought it advisable not to delay the publication of the descriptive part of this memoir any longer, and to complete it when the necessary preparations could be finished.

† See Letter No. 5, ALEXANDER AGASSIZ to CARLILE P. PATTERSON, on the explorations in the vicinity of the Tortugas in 1881. Bull. M. C. Z., VIII., No. 3, p. 145. I spent the months of March and April, 1881, at Key West and at the Tortugas, under the auspices of the United States Coast Survey, the late Mr. Patterson, the Superintendent, having kindly placed at my command a steam launch while engaged in examining the distribution of corals and studying the surface fauna of the Gulf Stream. The Hon. Secretary of the Navy kindly allowed the commanding officer at Key West, Lieutenant Winn, to give me permission to occupy the loft of the Navy storehouse as a laboratory.

will be seen, they have much less in common. This group of Hydrozoa is eminently characteristic of the Gulf Stream, and wherever its influence extends there Porpitæ, Velellæ, and Physaliæ have been found. In fact these surface animals are excellent guides to the course of the current of the Gulf Stream, — natural current bottles, as it were. They are thrown up along the whole length of the Atlantic Coast of the United States, from the Straits of Florida to the south shores of Cape Cod and of Nantucket. Physalia, Velella, and Porpita are occasionally driven into Narragansett Bay; the former is an annual visitant, the latter has only been found once, in 1875, and Velella has come into Newport harbor during three summers. It is undoubtedly also to the action of the Gulf Stream that we must ascribe the presence of the few species of Siphonophoræ which appear on the southern coast of New England towards the middle and last of September, such as Eudoxia, Epibulia, and Dyplophysa, which are all found at the Tortugas. On the contrary, Agalma and Nanomya are northern visitants at Newport, brought down by the arctic shore current from the northern side of Cape Cod, Agalma being common at Eastport. Other species of our southern New England free Hydroids, such as Eutima, Trachynema, Eucheilota, Liriope, Zanclea, and many other species which have been described by McCrady, from Charleston, S. C., are also brought north every year along the course of the Gulf Stream, and during the summer are blown to the westward towards the New England coast and the Atlantic coast of the Middle States by the prevailing south-westerly winds.

Velella mutica Bosc.

The Florida species of Velella occasionally finds its way north as far as Newport and Nantucket; it is found in great numbers in the Straits of Florida, between Cuba and the Florida reefs. Thousands of them are brought in by favorable winds and tides into Key West harbor, and are carried by the same agencies between the Tortugas channels. They are usually seen in large schools, and, although capable of considerable independent movement, by means of their tentacles, in a smooth sea, yet they are practically at the mercy of the winds and currents. They are destroyed in great numbers by even moderate waves, which, upsetting them, drive them ashore, or kill them, if they are kept keel downward for any length of time. They apparently need a considerable amount of movement, for when kept in confinement they do not thrive, soon die, and are rapidly decomposed. The dead floats are thrown upon the beach behind Fort Jefferson at the Tortugas in great numbers, forming regular windrows, and, when dry, are blown by the winds to the highest parts of the beach.

The Florida species is much larger than the Mediterranean *V. spirans*, Specimens measuring nearly four inches in length are not uncommon. On Plate I is figured in profile, from above and below, a huge Velella, nearly five inches in length. This is a somewhat unusual size. The outline of the mantle, seen from above, is less elliptical than in *V. spirans*, it is somewhat rectangular, with rounded corners (Pl. I, Fig. 2), and is also proportionally broader than in the Mediterranean species. Seen from above (Pl. I. Fig. 2), the color of the mantle is of a metallic bluish green, with a deep cobalt blue edge surrounding the outer edge of the float, and a similar band, forming an irregular ellipse with re-entering sides, placed somewhat diagonally across the float. Between these bands the color of the mantle passes rapidly from a yellowish green to the dark-blue inner and outer bands. Through the outer edge of the mantle the base of the outer blue tentacles of the lower side of the float can be indistinctly seen. The whole of the mantle is dotted with the patches of the so-called liver-cells, of a brownish color. The extreme edge of the dark outer part of the mantle is fringed with a light cobalt blue band, in which are placed the glandular organs of the free edge of the mantle. The free outer edge of the mantle is usually turned down so as to form slight indentations, or apparently sharp incisions in the general outline (Pl. I, Figs. 2, 3). The figure from below (Fig. 3) shows how the edge of the mantle is carried when folded under to produce the incisions seen from the upper side. The mantle, where it covers the central part of the float, is of a light greenish blue, with a metallic lustre, with a few patches of liver-cells, diminishing in number towards the base of the keel. The greenish lines of color form concentric lines parallel with the chambers of the float, crossed by triangular radiating rays extending from the fixed edge of the mantle towards the base of the keel, dividing the float into irregular alternating sections of light and colored triangular spaces. The keel is of a delicate steel color, with a thickened edge of the mantle (Pl. I, Fig. 2) running round it. In this the patches of liver-cells are closely packed together, and form dark-violet triangular patches, extending at right angles from the edge of the keel to the edge of the mantle. Seen from above the float is divided longitudinally by a long triangular band of liver-cells, which are seen through the float, so as to divide the float into two nearly equal parts (Pl. I, Fig. 1). Seen from below (Pl. I, Fig. 3), the mantle is of a lighter bluish green color, with a light blue edge (the marginal glands), followed by a somewhat darker belt passing into the greenish color of the mantle.

The tentacles (the closed prehensile polypites) are long, slender, of a bluish color, forming a double row round the outer edge of the float. The longest only of these tentacles extend beyond the free edge of the mantle so as to be seen projecting beyond it, when the Velella is viewed from above. These tentacular polypites taper very gradually; they seem capable of but slight expansion and contraction, and are quite sluggish compared with the smaller, active, feeding and reproductive polypites. These are arranged in five or six rows between the rows of tentacular polypites and the large central polypite (Pl. I, Fig. 3); the large, blue, prehensile, closed tentacular polypites are covered at the base (Pl. VI, Fig. 17) by elliptical or circular patches of lasso-cells (Pl. VI, Fig. 16), which about half-way towards the extremity become more crowded, and unite so as to form a band of lasso-cells on each side of the polypite (Pl. VI, Figs. 14, 15). In some young polypites the bands alone exist; while in others the elliptical patches alone are found (Pl. VI, Fig. 18). The smaller, the feeding and reproductive polypites are most active, and capable of great expansion and contraction. They are covered towards the upper extremity with elliptical knobs of lasso-cells (Pl. II. Figs. 5, 6, 7), the edge of the open extremity of the polypite forming ten to twelve indistinct lobes. At the base of the polypite there are, according to its size, from five to eight clusters of Medusæ buds, in different stages of development (Pl. II, Figs. 1, 5, 7). While the large central polypite is the main feeding mouth, the smaller lateral ones also perform, to a limited extent, the functions of feeding polypites; but, being all connected at their bases with the general vascular system, the fluids they take in enter at once into the general circulation. Both the central polypite, as well as the smaller lateral polypites, eject the digested substances which have gone through the general circulation.

As has been shown by Weissmann, the circulation of the fluids in the cœnosarc in fixed Hydroids is kept up mainly by the muscular contraction of the walls, or by the action of the ciliæ lining the cavities. A similar condition exists in the canals forming the vascular system of the float of Porpita and of Velella, and in the polypites, where the fluids are rapidly propelled by the action of ciliæ lining the inner walls.

The large, exterior, marginal, prehensile tentacles (Pl. VI, Fig. 14) are edged along the extremity with a band of lasso-cells, composed of large circular cells, closely packed together (Pl. VI, Fig. 15). Towards the base these bands of lasso-cells become disconnected (Pl. VI, Fig. 17), forming irregularly shaped disconnected circular patches (Pl. VI, Fig. 16). In young tentacles these bands of lasso-cells are not clearly defined, and when they first make their appearance they appear as patches near the base, gradually extending towards the extremity, there to form the connected bands of the older tentacles. The large prehensile tentacles, the feeding and reproductive polypites, are all attached to the lower side of the space occupied by the float, and to the part of the mantle immediately adjoining it. Huxley considers the tentacles of Velella, as well as those of the Porpitidæ, as identical with those of the Hydridæ Sertularidæ. The latter undoubtedly are to be so considered; but the structure of the tentacles of Velella clearly shows that they are embryonic tentacles, analogous to the "Fangfäden" of Physalia, and of other Siphonophores, in which the lasso-cells are arranged in the most simple form, as bands along the edge; while in Physalia they form the peculiar well-known reniform appendages paved with large lasso-cells. It is difficult in Velella and Porpita to distinguish the young polypite from the hydrocysts of other Siphonophores, and they do not appear to be present in those genera.

The small Medusæ buds already contain the peculiar yellow cells so characteristic of the free Medusæ. Those which I have raised from Velella (Pl. II, Figs. 15, 16) differ somewhat from that figured by Professor Agassiz (Contributions to the Nat. Hist. of the U. S., Vol. III, p. 53). On becoming free, the young Medusa (Pl. II, Fig. 10) has two rudimentary tentacles, one of which (t') is somewhat longer than the other (t), which is in this stage a mere tentacular knob. The close resemblance of the Medusa at this stage with such Tubularian Medusæ as Esuphysa, and Ectopleura is very striking. It has, like them, a row of large lasso-cells extending from the base of the tentacles (Pl. II, Fig. 14) to the abactinal pole (Pl. II, Figs. 10, 11, 13). The yellow cells are arranged in clusters along the sides of the four broad chymiferous tubes (Pl. II, Figs. 10, 11), as well as on the surface of the short, rounded, conical, rudimentary proboscis. The Medusa of Velella figured by Gegenbaur * has eight chymiferous tubes and one large tentacle; that figured by Vogt,† on the contrary, has only four chymiferous tubes, but

* Zeits. f. Wiss. Zool. VIII., Pl. VII, Fig. 10. 1856.
† Mém. Inst. Nat. Génevois, I. 1853, Pl. II.

eight rows of yellow cells, two on each side of the broad tubes, which may have misled Gegenbaur. The Medusæ buds figured by Kölliker * agree with the younger stages as figured by Vogt. The Medusa, when it first becomes free, is elongate, somewhat conical at the abactinal pole. After a couple of days the outline becomes flattened and more hemispherical (Pl. II, Fig. 11). The young Medusæ move with considerable activity by sudden jerks, like some of the Tubularian Medusæ. The tentacles did not increase in length during the time they were kept in confinement (ten days); nor did I fish up any others more advanced than those here figured (Pl. II, Fig. 11) during my stay at the Tortugas.

Kölliker has given an excellent account of the course of the so-called liver system in the Mediterranean species. I have been able to trace, as he has done, its ramifications through the mantle, over its free surface (Pl. IV, Fig. 14; Pl. V, Fig. 8), extending beyond the float (Pl. IV, Figs. 8, 11), to the edge, as well as the ramifications extending over the float and the surface of the keel (Pl. V, Figs. 1, 2, 4, 5). In addition to the two main branches of the system extending round the edge of the keel from the base of the float (Pl. V, Figs. 4, 5, v_o), there are two other large branches, which run across the float in the deep groove (Pl. III, Figs. 3, 14, 15, 17. *f.*), running obliquely across it. These two branches run up on each face of the keel (Pl. IV, Fig. 15. *v*; Pl. V, Figs. 1, 2. *v*) from the float, and then anastomose with the main branches described by Kölliker. All along their course, from the fixed edge of the mantle to the main branch running about parallel to the edge of the keel, the main branches give off a system of meshes and branches which cover the whole of the float and keel, and anastomose (Pl. IV, Fig. 5; Pl. V, Figs. 1, 2, 3, 4) with those extending over the mantle from the fixed edge of the mantle to its periphery. The secondary branches, forming the free edge of the mantle of the keel, which are given off from the main marginal branch, send off short simple secondary branches at right angles to the primaries, thus forming a sort of frill. The extremity of these tubes, again, is connected by a small marginal canal (Pl. V, Figs. 4, 5). The so-called liver † is suspended from the lower side of the float, running up into its conical portion (Pl. V, Fig. 11). The main longitudinal branches (Pl. V, Figs. 11, 12, 13. *l*) give rise to all the finer ramifications which extend through the whole thickness of the mantle. Fluids circulate with great rapidity

* Die Schwimmpolypen von Messina. 1853.

† In Velella and Porpita the hepatic organ, as has been pointed out by Huxley, occupies the same position with regard to the pneumatocyst which it occupies in Rhizophysa.

through the vascular system; and the terminal pouches of the liver are filled with the brown granular mass usually considered to be a true liver. The main tubes send off an endless number of fine ramifications (Pl. IV, Fig. 14), which assume all possible shapes from that of a flat, angular pouch (Pl. IV, Figs. 11, 12; Pl. V, Fig. 10), to an elongate, many-pointed star (Pl. IV, Fig. 15), or to a tube bristling with fine projections (Pl. IV, Fig. 14; Pl. V, Fig. 8), which become lost in the thickness of the mantle. The ramifications on the lower side of the mantle communicate with the reproductive individuals, as has already been seen by Vogt.

The central polypite is large, whitish (Pl. VI, Figs. 10, 11, 12, 13), with strong interior longitudinal muscular bands, capable of great expansion and contraction. It communicates at its base with the vascular system. Near the aperture of the central polypite we find the extremity covered with patches of small lasso-cells (Pl. VI, Fig. 22), forming near its opening irregular lips. The central opening is specially mobile.

There are but few air-tubes (tubules) starting from the lower surface of the float, and forcing their way through the liver to the base of the reproductive polypites. The majority terminate as a single tube, and they rarely ramify, as is stated to be the case by Krohn, in the Mediterranean species. The air tubes vary greatly in number in different specimens. They take their origin from the lower side of the float, in the five or six chambers nearest the centre (Pl. III, Figs. 18, 19, 20). They generally occur two or three together, sometimes in tufts of four starting close together. They sometimes branch, as has been described by Krohn,* but apparently not as commonly as is the case in the Mediterranean species. The air tubes extend through the liver in a more or less winding course (Pl. III., Figs. 20, 21,) (but much more directly than in Porpita), and find their way to the base of a few of the small feeding and reproductive polypites (Pl. VI, Fig. 19). In the only case where I have succeeded in tracing the termination of the air sac, it ended in a blind tube. The air tubes are arranged much like those of Porpita, so that their course can be traced on the upper side of the liver when the float is removed and we examine the liver from the upper side. The outer partitions of the interior chambers of the float, where the air tubes take their origin, extend in a series of prongs and processes (Pl. III, Fig. 19) beyond the general surface of the float, so that the rough walls of these inner chambers are in marked contrast to the smooth outer walls of the other chambers of the float.

* Archiv f. Naturg., 1848, I. p. 30.

The mantle covering the float extends, as is well known, not only over the horizontal surface of the float, but also over the sail. It projects beyond that, forming a sort of flap (Pl. V, Fig. 4), much as the mantle projects beyond the horizontal part of the float. From the two extremities of the float, at the base of the keel or sail, there runs along the free edge a large tube of the vascular system (described by Kölliker and Vogt), from which branch the dendritic processes forming the triangular patches (Pl. V., Figs. 4, 5) of the free edge of the mantle of the keel. This free sail mantle is of a light claret color, with a blue edge, and with bluish branching tubes forming the ramifications of the vascular system. These tubes anastomose again at the outer edge, forming an irregular marginal canal. There are no glands to the free edge of the keel mantle (Pl. V, Fig. 5), like those found on the free edge of the horizontal mantle of the float. The yellow cells of the sail mantle are packed principally in patches at the extremities of short tubes opening into the main canal, fringing the keel at the base of the free sail mantle (Pl. IV, Fig. 5, Pl. V, Figs. 2, 10). The dendritic tubes are a series of flattened elliptical pouches, opening into one another, and joined together by frill-like folds of the main tubes (Pl. V, Fig. 7). The two surfaces of the mantle join at the edge of the float, so that the part of the mantle which covers the sail and extends to the outer edge of the float, unites there with that part of the mantle which protects the inner side of the float, and to which the appendages of the lower surface are attached. These two surfaces, thus soldered together, extend some distance beyond the float, forming the free edge of the mantle of the Velella. The mantle itself is slightly contractile, and whenever the Velella is thrown over into any unnatural attitude, or forced on its side, it makes violent attempts by the movement of its prehensile tentacles, aided by movements of the free margin of the mantle, to recover its normal attitude.

Rhizophysa and other Siphonophores are capable of sinking below the surface and swimming back to the surface, but neither Velella nor Porpita appear capable of such movements, a very young Physalia, collected at the Tortugas, intermediate between the stages figured by Huxley (Oceanic Hydrozoa, Pl. X, Figs. 1, 2), was found to swim at various levels in the jar in which it was kept.

All the Velellæ floats I have examined are left-handed, that is, the sail runs northwest to southeast, the longitudinal axis of the float being placed north and south. I have counted over twenty-five hundred dead floats, thrown on the beaches at the Tortugas, in all of which the position of the float was as stated above.

The young stages of Velella differ very materially in appearance from the full-grown Velella. In the youngest stage I have had the opportunity to examine, the sail forms a flat elliptical arch (Pl. VI, Fig. 8), extending well beyond the extremities of the conical float, the mantle forming an umbrella-shaped projection, below which extend, when expanded, the eight marginal tentacles and the large central polypite. The rudimentary small feeding polypites are about as numerous as the tentacles, and form an inner ring at their base, much as in the older stages figured here (Pl. VI, Figs. 2, 3). The vascular system extends in straight vessels radiating from the float through the mantle to the outer edge. In a somewhat older stage, seen from the lower side (Pl. VI, Fig. 3), the marginal tentacles and feeding polypites are more numerous, the vessels of the liver system more clearly defined, the sail has become somewhat conical, and the whole float and mantle somewhat flattened. In a still more advanced stage (Pl. VI, Fig. 1), the sail has become more conical, the float greatly flattened, and the canals of the liver system clearly defined, as is well seen in a view from the lower side (Pl. VI, Fig. 2). The central polypite (Pl. VI., Figs. 1, 2 *cp.*) at this stage is most prominent, capable of great expansion; the feeding polypites have greatly increased in number as well as size; there are as yet no signs of the reproductive polypites.

Stuart* has given a detailed development of the Medusa of Velella, and traced it directly to a free Medusa with four chymiferous tubes with large masses of yellow cells along the tubes. These Medusæ he kept alive for a few days, but could trace no further stages of development. The oldest Medusa he observed showed as yet no sign of any tentacular appendages. Stuart, however, seemed satisfied that the Chrysomitra of Gegenbauer, having sixteen chymiferous tubes and two distinct tentacles with tentacular knobs at the base of the tubes, was really a more advanced stage of the Medusa of Velella, though he did not observe the intermediate stages of development between it and the Medusæ he raised directly from Velella.

The youngest Velella figured by Huxley (Oceanic Hydrozoa, Pl. XI, Fig. 9) measured about one tenth of an inch in length. He noticed that the pneumatocyst did not extend into the crest, in which he also saw the rudimentary canals extending from the limb to the crest. On examining the pneumatocyst he found a single central vesicle with the first trace of a concentric line, the rudiment of the first concentric chamber. This structure agrees well

* Archiv f. Anat. Phys. u. Wiss. Med. 1870, p. 366.

with that of a young Velella, and differs radically from that given by Pagenstecher for Rataria (as young Velella?), in which the pneumatocyst clearly shows the eight primary divisions so characteristic of Porpita with the central opening of the disk. Huxley also observed that in young Velellae the hepatic mass does not exist, and is only gradually developed under the pneumatocyst, and that the canals which cross it are mere subdivisions of the somatic cavity produced by the lobes of this organ and their mutual anastomoses. My observations on Velella lead me to agree with Kölliker regarding the mode of junction of the liver canals and of the canals on the free edge of the mantle and on the upper part of the float. The dendritic-like structure of the canals of the crest have also been noticed by Huxley in a young Velella measuring somewhat less than half an inch in length. The circulation within the canals was most active, and wholly due to ciliary action. The figures given by Huxley (page 126, Oceanic Hydrozoa) of the peculiar corrugations and lobes of the lower surface of the float, being taken from alcoholic specimens, are not quite satisfactory representations of their appearance in fresh specimens.

As has already been suggested by Kölliker, Agassiz, and McCrady, the relationship of the Velellidæ and Porpitidæ, as well as the Physalidæ,* to the Tubularian Hydroids is very great. If we compare this group as a whole to the other Siphonophores, the absence of "Deckstücke" and of swimming bells seems to distinguish them from all the other Siphonophores except Rhizophyza, which perhaps is only a representative of the embryonic stage of the Physalidæ, and does not belong into the close association with the other Siphonophores, with which it has usually been placed. What is known of these different families seems to indicate a far closer relationship with the Tubularian Hydroids, such as Hydractinia, which may perhaps be the closest ally of the genera named above, and in which the chitinous exten-

* The chambers of the crest of Physalia can be considered as a sort of girder which stiffens the whole float, and to a certain extent takes the place of the chitinous crest of Velella. The structure of the crest is seen in section to be a broadly rectangular triangular cell, subdivided by horizontal bars to form the smaller trapezoidal cells of a second, third, fourth, and fifth story, adjoining triangles being again connected longitudinally by similar bars. The float of Physalia remains in fact in the embryonic stage in which we find the sail or crest of Velella and young Porpita. In the latter the crest gradually disappears to cover the upper part of the float; in the former it continues through to the mature stage, being supported by a chitinous vertical projection from the float, which is absent in younger stages, while in Physalia we have only the mantle, if I may so call it, of the crest left, the pneumatophore not secreting a chitinous float or any structure homologous to the circular chitinous float of Velella or the chitinous disk of Porpita. The presence of a net-work of canals at the base of the float of Physalia, similar to that of the upper part of the float of Velella Porpita, has been made probable by some observations of Quatrefages. (Ann. Scien. Nat. 1853).

sion of the base of the cœnosarc may perhaps be considered as the first indication of the formation of a float. In this case this rudimentary pneumatophore is attached to the ground or to a movable body-like Fusus, etc., and forms papillæ, between which arise the two different kinds of polypites, the sterile tentacular polypite and the reproducive polypite, giving rise to either male or female colonies. This combination is exactly similar to that of Porpita, in which we have a chitinous float and tentacular and proliferous polypites arranged in addition round a central sterile polypite.

The homologies we have attempted to trace between Porpita and the Tubularian Hydroids might perhaps be still further extended. It is well known that in nearly all Tubularians the base of the cœnosarc, by which they are attached to the ground, extends either as filaments or rootlets over a considerable space; these filaments, or expansions of the chitinous tubes, forming either a connected series of canals, more or less complicated, as in Clava, Cordylophora, Coryne, etc., or a net-work of canals as in Dicoryne, Bougainvillia, Tubularia, Hydractinia, Podocoryne, etc.; or else such filamentary processes as those of Corymorpha, in all of which there is a more or less active circulation connected with that of the cavity of the Tubularian. In Corymorpha we find a series of longitudinal canals, more or less branching and anastomosing, extending along the cœnosarc. Let us now imagine this long Corymorpha cœnosarc reduced in length and at the same time flattened so as to form a disk somewhat below the base of the tentacles, retaining its peculiar pointed terminal basal extremity. We could thus have a free Hydroid differing but little from Velella and Porpita; that is, our Corymorpha would be transformed to a Hydroid, with a crown of marginal tentacles below the chitinous disk, in which there are canals of the vascular system. Between this row of marginal tentacles and the large central opening of the polypite we find clusters of reproductive Medusæ. Imagine the same transformation in a colony of Hydractinia, or of Podocoryne, in which we find the chitinous disk already formed and traversed by a network of canals, and add to it a central sterile polypite, and we have all the structural features of a modified Porpita, namely, a disk, rows of tentacular polypites, next rows of reproductive and feeding polypites, while if we make the same comparison with Hydractinia we add a third kind of appendage, the so-called spiral zoöids.

An examination of very young stages of Tubularians, such as, for instance, the very early stages of Endendrium figured by Allman (Pl. XIII, Figs. 14–16, Tubularian Hydroids), show such a chitinous disk to be compared in every respect with the float of Velella or of Porpita, with broadly open ramifications communicating with the base of the single large central polypite, and differing from it only in being fixed. We can readily imagine a slightly more advanced stage, with the additional proliferous polypites, or others, developed at the base of the central polypite and setting the attached disk free, we have to all appearances a somewhat modified Porpita or Velella.

But Porpita seems to be also allied to another group of Hydroids, with which thus far no attempt has been made to compare them. I mean the Hydrocorallinæ. My basis for this comparison rests upon the presence of the singular white plate of Kölliker, and of its peculiar structure, — which reminds us of the porous structure of the corallum of Sporadopora, Allopora, Millepora, etc., although, of course, not having the regular horizontal floors of the latter, yet possessing, like these genera, large pits, the whole mass being riddled with passages and openings, forming the spongy mass of the white plate. Although some of the proliferous polypites of Porpita appear to rise from the larger of these pits, yet the others do not seem to hold any definite relation to them, beyond the fact that these proliferous polypites are limited to the ring occupied by this white plate. If this homology is correct, it shows how far-reaching are the affinities of the Porpitidæ, — on the one side recalling from the structure of their white plate the corallum of Milleporidæ, which date back to the cretaceous period; and, on the other, the similar structure of the Helioporidæ, which, as is well known, have been shown by Moseley to be Halcyonoids. Whether the Stromatoporæ have any relationship to either of these groups or are sponges cannot at present be determined; but should they be related to the Milleporidæ, the peculiar structure of the corallum of the Milleporidæ, Stylasteridæ, and Porpitidæ would date back to the earliest Silurian. It is interesting to speculate, if the affinity of Porpita is greater to the Milleporidæ with a porous fixed corallum, or to the Tubularians having only a chitinous fixed basis.

Porpita Linnæana Less.

Kölliker * was the first to give a detailed description of the Mediterranean Porpita. The Florida species is closely allied to it. It differs from it in size, the largest of our specimens measuring no less than $1\frac{1}{8}''$ in diameter, while the medium size of the P. Mediterraneana is only 4 to $5'''$ in diameter.

* Die Schwimmpolypen v. Messina, 1853, p. 57, Pl. XII.

As will be seen from the accompanying description, the other differences to be noted between the Florida and the Mediterranean species are: the numerous and close corrugations of the lower surface of the disk; its great roughness on the upper side; the comparatively greater length of the primary polypites; the smaller size of the proliferous polypites. The shape of the former is very different from those of the Mediterranean species, ending in three to four large knobs, with three longitudinal rows of smaller tentacular knobs, — six in two of the rows, and from eight to nine in the central row (Pl. X, Figs. 3, 5, 7).

As in the Mediterranean species, the disk is circular, slightly cup-shaped, convex above, made up of two disks, thickest near the outer edges, and united together by a series of circular walls entirely separated from one another (Pl. XI, Figs. 7–13). The circular chambers thus formed open outwardly by small elliptical openings giving air free access to them (Pl. XI, Figs. 7–9, 12, *o*). These chambers are filled with air (gas ?), giving to the Porpita its great buoyancy. The enclosed air (gas ?), shining through the float and the thin mantle which covers the disk, gives to its upper side a strong silvery lustre. The upper side of the disk is but slightly corrugated, with radial depressions, the stigmata being placed in the centre of low projections, forming an irregular elevation in the lines of corrugations of the disk (Pl. XI, Fig. 7). There is a large central chamber, with an irregular ring of eight smaller ones (Pl. IX, Figs. 1–4), corresponding to the eight first-formed triangular chambers, placed round the central chamber. There does not seem to be beyond that first row any regular arrangement in the stigmata, or any order in their appearance or number. They vary greatly in position and in number in specimens of the same size. The stigmata are more numerous, as well as larger, near the edge of the disk, as has already been noticed by Kölliker.

The ribbed structure of the lower side of the disk does not seem to have been observed. The lower floor of the radiating chambers extends into deep longitudinal corrugations (Pl. XI, Figs. 5, 8–11, 13, 14), forming immense pouches, as it were; so that when seen endwise they present the appearance of high-pointed bags, with rounded tips, and deep spaces between them (Pl. XI, Figs. 13, 14). A transverse (Pl. XI, Figs. 8, 9) and a longitudinal view (Pl. XI, Figs. 10, 11), will give a better idea of their peculiar structure than any lengthy description. To the under side of these pouches are attached the tubules (Pl. XI, Figs. 1, 2, 3, 5, 8, 9), they are irregularly placed in single rows

(Pl. XI, Fig. 5), and are not arranged in sets of three, as they are represented by Kölliker as characteristic of the Mediterranean species. The tubules commence about the outer edge of the white plate, and are most numerous towards its central part (Pl. XI, Fig. 2), where they come to the inner surface, and literally cover it with a matting of winding silvery threads (Pl. XI, Figs. 1, 4). Towards the centre of the float they become less numerous again (Pl. XI, Fig. 3), ending with six or seven tubules, which take their origin near the eight primary chambers, and extend over that part of the float.

Porpita is not as easily upset as Velella; and the number of specimens thrown ashore by the winds is very small, as compared to the numbers of Velellæ stranded on the beaches after every storm. Porpita is capable of considerable control over its movements. Owing to the great size and power of its numerous long marginal tentacles, it can readily force itself back again into a normal attitude, if upset by the wind or waves. It can, by bringing its tentacles together over the disk (Pl. X, Fig. 1), and throwing up the free edge of the mantle slowly in a given direction, then expanding the tentacles of one side far over on the opposite direction beyond the central part of the disk, it can thus readily change the centre of gravity, and tilt the disk back again into a normal attitude, should it from any cause have been set afloat with the tentacles uppermost. The larger outer marginal polypites are arranged in three or four irregularly concentric rows, with two to three inner rows of smaller knobbed tentacles, in all stages of development (Pl. X, Figs. 2, 3, 10, 11). Inside of these are arranged, in from five to six similar rows, round the base of the large central polypite, the small, stout, flesh-colored feeding and reproductive polypites (Pl. X, Figs. 4, 5). These have a slightly rectangular head (Pl. VIII, Figs. 1–4), capable of considerable expansion, with four clusters of lasso-cells at the thick rounded angles of the terminal opening. At the base of these polypites are found Medusæ buds in all stages of development (Pl. VIII, Figs. 1–4; Pl. X, Fig. 4). At the time when in full reproductive power these clusters of Medusæ completely fill the whole space between the small polypites, giving to the ring which they occupy on the lower surface of the float a dark yellowish tint from the color of the yellow cells found along the rudimentary proboscis of the Medusæ buds, as well as along the chymiferous tubes (Pl. VIII, Figs. 1, 2, 4–11).

The large marginal tentacles (Pl. X, Fig. 3) are of a bluish tint, the tentacular knobs of a darker color. The internal cavity of the tentacles has a somewhat greenish tint, and connects at the base of the tentacle with the vascular system of the lower part of the mantle at the point of attachment. The cavity leading to the tentacular knobs is very slender (Pl. X, Fig. 8).

The smaller polypites (the feeding-reproductive polypites) occupy on the lower surface that portion of the mantle which covers the ring formed by the so-called white plate of Kölliker, round the base of the single central polypite. These polypites are sometimes seated in cavities of this white plate, and projections of the plate itself also extend sometimes far up into the lower part of the small polypites.

The white plate consists of an irregularly anastomosing system of needles and spurs, or of bars of greater or smaller size, leaving a series of openings for the passage of the tubules (Pl. VIII, Figs. 1, 1[a]; Pl. IX, Fig. 11). These tubules take their origin on the lower side of the disk, run in all possible directions between the interstices of the white plate, and come out as blind sacs on its lower side (Pl. XI, Fig. 1). Some of these tubules extend along the side of the small polypites (Pl. VIII, Figs. 1, 2, 4), while others follow the extension of the white plate (Pl. X, Figs. 4, 6), into the base of the central polypite some distance up its walls, forming a most delicate frill (Pl. X, Fig. 4, *t*) of silvery radiating lines, extending towards the mouth of the central polypite. If this white plate is a kind of kidney, as Kölliker suggests, its openings lead outwards through the cavity of the central polypite, as well as through the openings of the smaller reproductive polypites, which are placed on the ring it forms round the central polypite (Pl. VIII, Fig. 1), and into the base of which this white plate extends a considerable distance. Although Kölliker calls it the "white plate," it is in reality of a pinkish color toward the periphery, and blueish towards the interior edge, the whole of the part which lies within the base of the central polypite being of that color. The inner part of the ring of the white plate is composed of heavier bars, the edges only being spongy (Pl. XII, Fig. 15).

The liver (Pl. VIII, Figs. 1, 1[a], *l*, 16) occupies the whole of the space between the lower surface of the disk, the level of the white plate and the base of the central polypite. It fits closely into all the corrugations of the lower side of the disk, as well as into the upper ramifications of the white plate. It sends out a complicated system of radiating and anastomosing tubes from the centre towards the margin of the mantle, in which the circulation is kept up very actively (Pl. XII, Fig. 13). In younger specimens the radiating tubes are still quite simple (Pl. IX, Figs. 1–4; Pl. XII, Figs, 1–8). With increasing size, they become somewhat more branching, and finally, near the outer edge, more or less parallel with the ring of marginal glands, there is formed a series of irregular horizontal canals connecting the radiating tubes, and forming thus a more or less apparent circular canal (Pl. XII, Figs. 9, 10, 11), till finally the whole free edge of the mantle is covered by a most intricate set of anastomosing tubes (Pl. XII, Fig. 13). The free edge of the mantle terminates by a row of large elliptical glands (Pl. XII, Figs. 4–13; Pl. VIII, Fig. 16), the interior of which is filled by fatty, globular cells (Pl. VIII, Fig. 17). The whole of the free edge of the mantle is of a beautiful clear blue color, with a dark band at the line of contact of the disk and the inner seam of the free edge of the mantle, with a darker blue line on the outer edge of the glands, both at the exterior and interior edge (Pl. VII, Fig. 2). The whole surface of the mantle is covered by a close reticulation of irregular epithelial cells.

The smallest (so-called Velellæ) Rataria examined by Pagenstecher measured between 0.8 and 2.25^{mm}, and it seems impossible from what I have said here regarding the young stages of Velella and of Porpita which I have had the opportunity to examine to consider Rataria as anything but the young of Porpita, as Burmeister had already done. The young Porpita in its Rataria stage passes through an embryonic stage, in which the young Porpita has a prominent sail fully as marked as the sail of the corresponding stage in Velella. This stage, to a certain extent, recalls strongly Velella. That this embryonic character gradually disappears with age, has been shown by Pagenstecher; but the succeeding stages do not lead, as has been supposed, to Velella, but to Porpita. At no time in the development of Velella do we have any trace of eight compartments arranged round a central chamber. We have, it is true, a central chamber; but there are only concentric chambers in the earliest stages I have seen; while the Rataria stages figured by Pagenstecher * correspond admirably to the young stage of Porpita I found at the Tortugas, in which the eight central chambers occupy the greater part of the disk, and can, as is well known, still be traced in fully grown specimens.

* Zeits. f. Wiss. Zool., XII., 1863, Pls. XL, XLI, p. 496.

PLATE I.

FIG. 1. Velella mutica, seen in profile; natural size.

FIG. 2. The same, seen from above.

FIG. 3. The same, seen from below, with a small cluster of reproductive polypites, magnified four diameters.

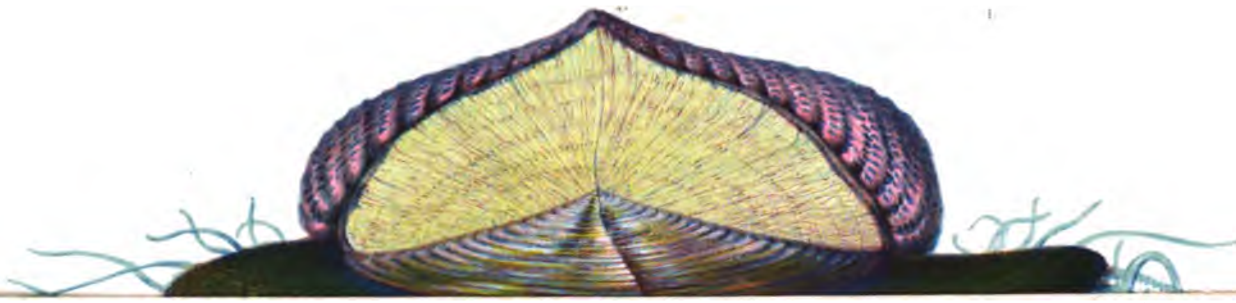

PLATE II.

Fig. 1. Larger kind of reproductive polypite of adult Velella: *a*, actinal opening; *b*, clusters of lasso-cells forming patches over the surface of the upper extremity of the polypite; *mm*, clusters of medusæ buds in different stages of development, magnified.

Fig. 2. Actinal opening of feeding polypite. Fig. 4.

Fig. 3. Another view of the actinal opening of a reproductive polypite.

Fig. 4. Magnified view of larger feeding polypite; in these the patches of lasso-cells are but slightly developed towards the free extremity; near the base, however, they form huge spheres *b'b'*, studded in part with gigantic lasso-cells.

Fig. 5. Smaller kind of reproductive polypite, more slender than Fig. 1, with a smaller number of medusæ buds. The patches of lasso-cells are clustered together so as to form hemispherical projections, which become slightly pedunculated towards the base.

Fig. 6. Magnified view of two of the hemispherical clusters of lasso-cells of the surface of one of the smaller proliferous polypites. These polypites are open at the extremity.

Fig. 7. Another view of a smaller proliferous polypite distended with food.

Fig. 8. Small and slender feeding polypite. Lettering as in Fig. 4.

Fig. 9. Actinal extremity of one of the smaller kinds of feeding polypites greatly extended.

Fig. 10. Medusæ of Velella freed twelve hours from the reproductive polypites: *d*, digestive cavity; *ch*, chymiferous tubes; *y*, yellow cells; *l*, one of the large lasso-cells forming the four lines running from the tentacles to the apex; *tt'*, large and small rudimentary tentacle; *m*, actinostome.

Fig. 11. Somewhat older than preceding stage. Lettering as above.

Fig. 12. Fig. 10 seen from above with the sides of the bell slightly drawn in.

Fig. 13. Young Velella just before it separates from the proliferous polypites.

Fig. 14. Magnified view of the base of the rudimentary tentacular bulb: *l*, outer line of lasso-cells in the periphery of the bell; *t*, rudimentary tentacle; *g*, clusters of yellow cells.

Fig. 15. Medusa of Velella copied from drawings for L. Agassiz's Contributions to the Natural History of the United States.

Fig. 16. Same seen from the abactinal pole.

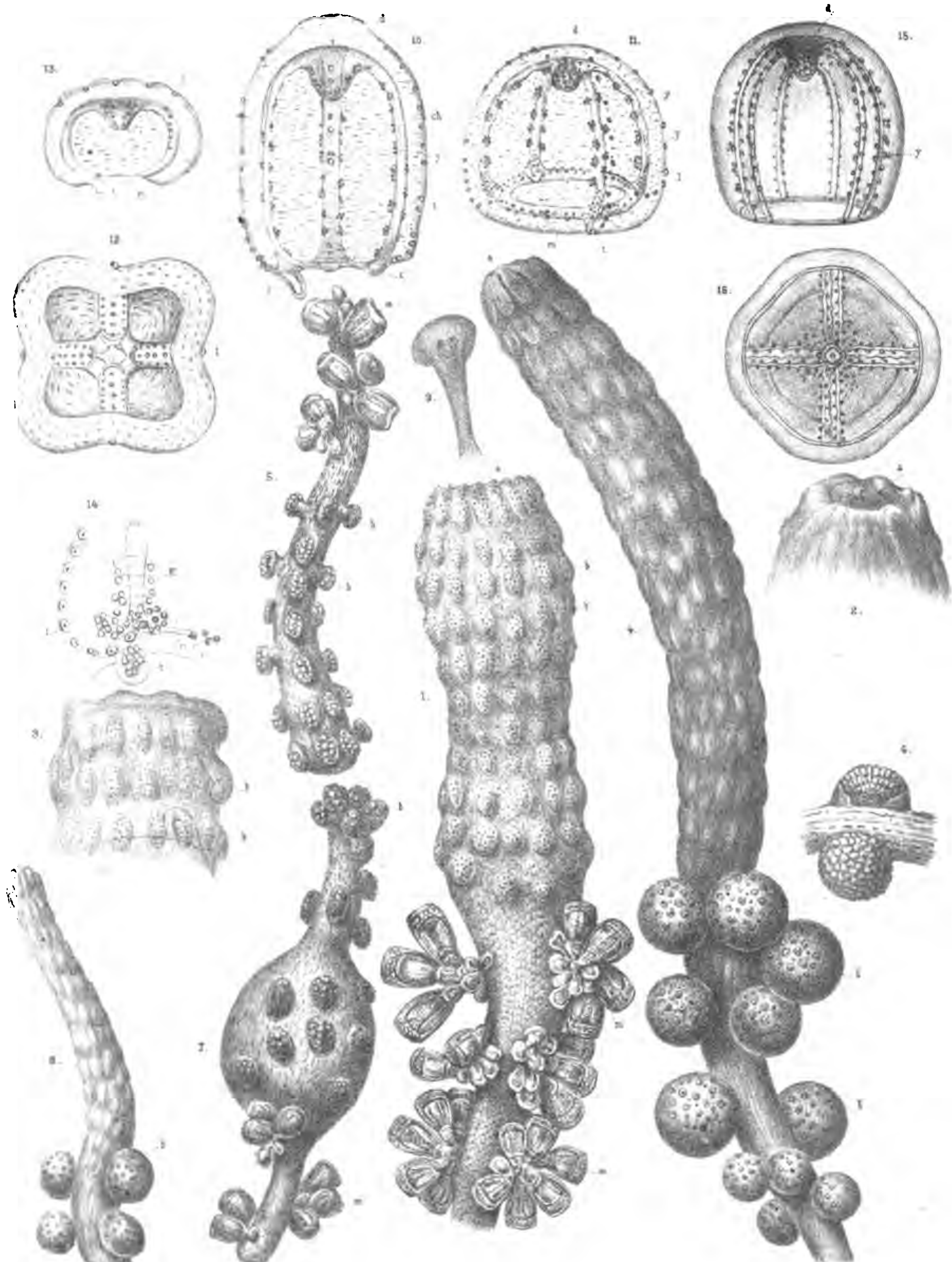

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PLATE III.

Fig. 1. Float of young Velella seen from above, $\frac{1}{16}$ of an inch in length : ff' groove in which the main branch of the circulatory system passes from the fixed edge of the float to the base of the keel. In this stage the keel is a slight ridge surmounting the single central chamber: $o'o''$, apertures opening externally from the fifth and seventh chamber on the right, and from the second and fourth on the left.

Fig. 2. The same as Fig. 1, seen in profile, showing the central chamber round which are arranged, in an irregular elliptical shape, the eight chambers of which the float, at this stage, is composed: *tt*, so called air tubes attached to the lower side of the float; *f*, groove of main branch of circulatory system.

Fig. 3. Float of a young Velella measuring $\frac{3}{16}$ of an inch. Lettering as above; $o'''o'''$, apertures opening externally from the ninth and sixth chambers on the right and left.

Fig. 4. Profile view of the float of a young Velella having eight chambers, measuring $\frac{1}{4}$ of an inch in length. Lettering as in Fig. 2. The keel, a', rises quite perceptibly above the central chamber on a slight conical projection: a^1–a^8, successive chambers of the float.

Fig. 5. Profile view of Fig. 3. Lettering as before. The keel has greatly increased in height and the second line of growth is apparent.

Fig. 6. Float of young Velella with twelve chambers measuring $\frac{1}{4}$ of an inch in length and having seven lines of growth in the keel, which, in this stage, is a high conical lamella of entirely different proportions to the float than in the adult or larger specimens.

Fig. 7. Profile of central part of the float and keel of a young Velella with twelve chambers, but only four lines of growth in the keel; this is also much broader than is usually the case at this stage, — $\frac{5}{16}''$ in length.

Fig. 8. Profile of young Velella with seventeen chambers in the float, measuring $\frac{7}{16}''$ in length, with six lines of growth in the keel.

Fig. 9. Portion of horizontal surface of the float of young Velella with twelve chambers, showing the openings leading from one chamber to the adjoining ones through the common walls ; the opening in the last chamber opens externally.

Fig. 10. Showing on a somewhat larger scale the passages leading from one chamber to the other in the eight outer chambers of the float of the preceding figure.

Figs. 11, 12, 13. Opening in the outer chamber of three young Velellæ varying in size from $\frac{1}{4}$ to nearly $\frac{1}{2}$ an inch in length. This opening is always in continuation of the line of openings forming the communication between adjoining chambers.

Fig. 15. Diagrammatic transverse section of young Velella with twelve chambers, showing the position of the keel a', the central chamber a, and the concentric chambers a^1–a^{12} with the groove f for the main branch of the circulatory system.

Fig. 16. Diagrammatic section of the float of a Velella with twenty-two chambers.

Fig. 17. The corresponding section of the opposite side showing the position of the groove f. This groove is only a fold of the upper walls of the chambers, and does not divide the chambers into distinct spaces ; they form each a continuous ring.

Fig. 18. General view of the position of the clusters of tubules arising from the lower side of the four inner chambers ; some of the tubules branch, a rare occurrence in our Velella.

Fig. 19. Inner view of the conical part of the float of a large Velella, showing the position of the tubules and the corrugations and folds of the lower walls of the inner chambers; the corrugations *ccc* become less prominent in proportion to the distance from the central chamber; near the margin of the float the walls merely bulge out and form slight undulations.

Fig. 20. Tubules of a large Velella which have penetrated through the so-called liver, and appear on the top of the liver when seen from the lower side of the cone of the float.

Fig. 21. View from the inside of the central part of the float showing the tubules of a young Velella measuring about $\frac{1}{4}''$ in length.

Fig. 22. Basal part of three tubules near the attachment to the central chamber in a Velella measuring about $\frac{1}{2}$ an inch in length.

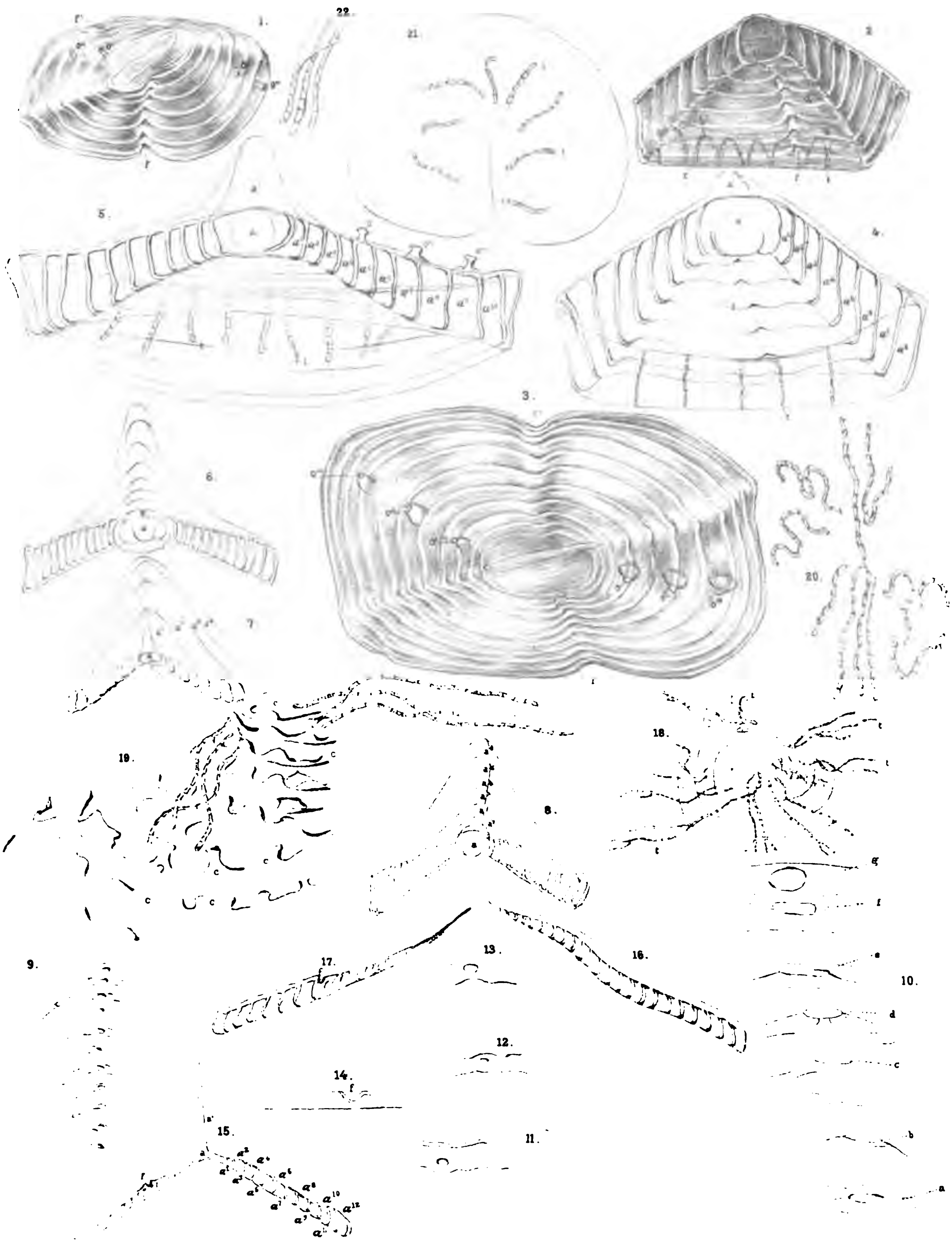

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PLATE IV.

FIG. 1. Profile view of the keel and float of small Velella, measuring about ½ inch in length: *c a*, outer chamber of the float; *a*, one of the concentric chambers; *l*, so-called liver; *p*, folds of the mantle covering the keel extending from the canal at the base of the keel to the canal *e* at the edge of the mantle.

FIG. 2. Small Velella, about ⅛ of an inch in length, (seen from above) showing the few ramifications of the so-called liver system, *l*, seen through the float; *s*, rudimentary keel; *fl*, free edge of the mantle.

FIG. 3. Slightly more magnified view of a part of the edge of a young Velella, somewhat older than the preceding figure: *v*, principal ramifications; *v′*, secondary ramifications of the free edge of the mantle.

FIG. 4. Portion of the edge of a small Velella, measuring $\frac{3}{16}$ of an inch in length: *v″*, primary ramifications; *v′*, secondary branches; *g*, marginal glands of the free edge of the mantle, seen from above.

FIG. 5. Portion of the edge of a small Velella, slightly older than the preceding figure, in which the principal ramifications still extend to the free edge of the mantle.

FIG. 6. Portion of the edge of the float of a small Velella, about in the same stage as the preceding figure, with proportionally larger marginal glands, but shorter secondary ramifications, than in Fig. 4.

FIG. 7. Portion of the edge of the mantle of a Velella measuring about one inch in length, with long marginal glands *g*, with a simple free edge of the mantle *e*, extending beyond, and small clusters of yellow cells *c*, moderately closely packed along the outer edge of the mantle.

FIG. 8. Portion of the edge of the mantle of a Velella, measuring about two inches in length, with a fringed free edge of the mantle *e*, beyond the marginal glands *g*, with large patches of yellow cells *c*, closely packed together over the whole of the free edge of the horizontal mantle beyond the float.

FIG. 9. Somewhat more magnified view of a part of the horizontal mantle of the float, to show the shape of the ramifications of the so-called liver canals extending between the patches of yellow cells.

FIG. 10. Single cluster of yellow cells with the fan-shaped terminations of the liver canals.

FIG. 11. Portion of the outer edge of the horizontal mantle of a Velella, in which the ramifications of the vascular system terminate in sacs more or less filled with clusters of yellow cells.

FIG. 12. Separate clusters of terminal extremities of the vascular system of a Velella nearly in the stage of the preceding figure, taken near the edge of the float.

FIG. 13 Pouch-like terminal clusters of the vascular system filled with yellow cells, seen from above near the glandular band of the mantle.

FIG. 14. Shows the delicate dendritic ramifications of the large vascular (liver) canals seen from the lower side of the float, entirely free from accumulations of yellow cells.

FIG. 15. Part of one of the main vascular tubes, with large star-shaped ramifications and large clusters of yellow cells, seen from the upper surface, near the float.

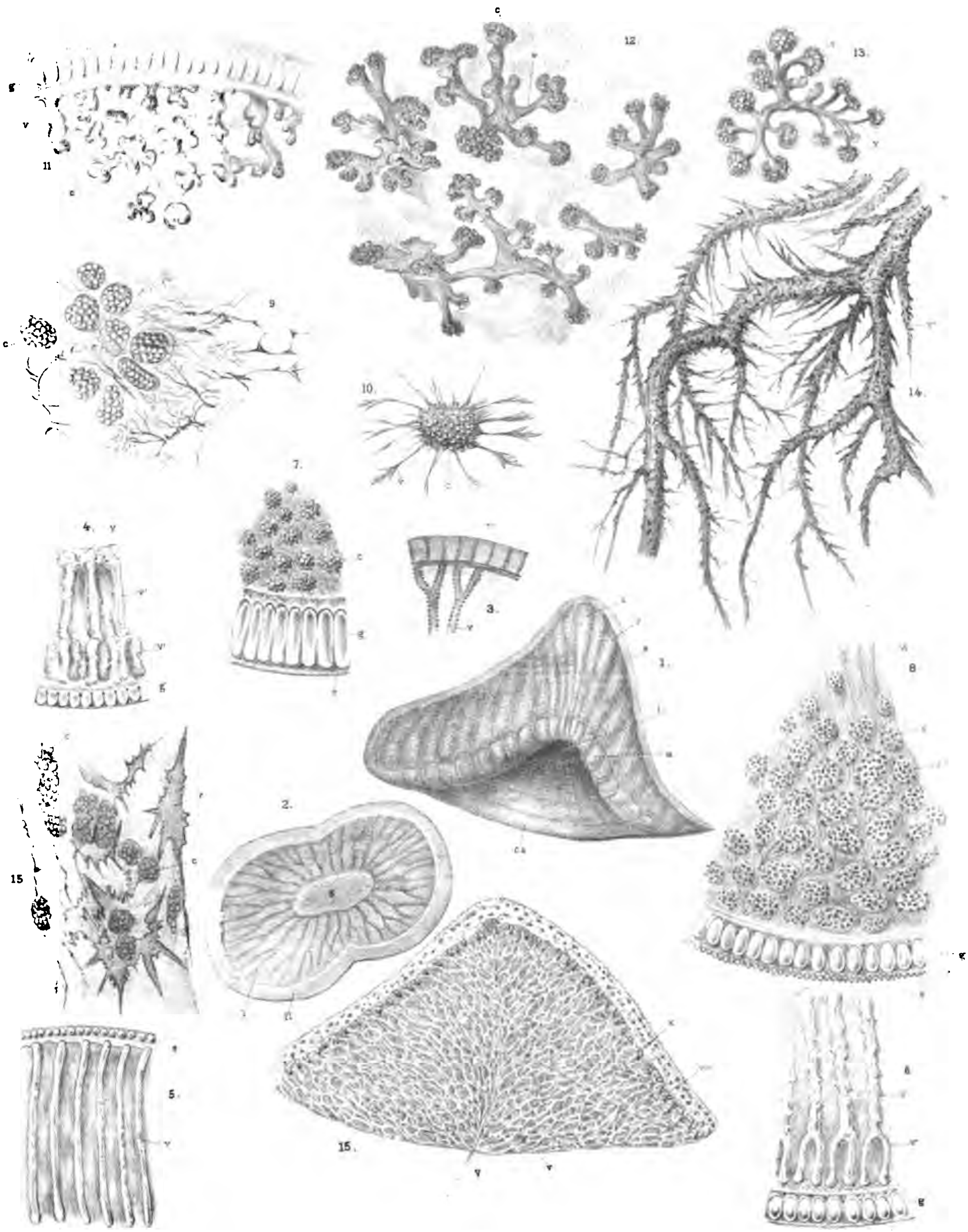

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PLATE V

FIG. 1. Half of the keel of a Velella measuring one and a half inches in length, showing the principal tube *v*, with its anastomoses extending to the broad marginal canal, from which proceed the dendritic tubes extending to the edge of the mantle of the keel of Figs. 4, 5.

FIG. 2. Somewhat more magnified view of a portion of the keel of the preceding figure, showing more distinctly the principal central branch, with its anastomoses, and the large blind sac-like pouches (see Fig. 10) formed along certain parts of the main circular canal of the keel. The pouches are filled with clusters of yellow cells; there are also smaller patches of yellow cells in the circular canal.

FIG. 3. Still more magnified than preceding figure, to show the position of the clusters of yellow cells *y*, near the edge and in the circular canal.

FIG. 4. Half of the keel of a Velella slightly larger than the preceding figures, showing the main central vascular branch *v*, the amastomosing branches v'', extending over the whole surface of the keel to the circular canal v°, running nearly parallel to the outer free edge of the keel. From this circular canal branch off the dendritic canals v', which unite again along the free edge of the mantle of the keel.

FIG. 5. Magnified view of two of the dendritic canals of the free edge of the mantle of the keel; v°, circular canal, from which arise the main branches v', of the dendritic canals v'', which unite again in a marginal canal v''', along the outer edge of the keel mantle.

FIGS. 6, 9. Ramifications of the vascular system from the lower side of the float, with clusters of apparently decomposed or dead yellow cells.

FIG. 7. Magnified view of the frill-like ramifications, $v\ v'$, of the so-called dendritic branches of the vascular system of Fig. 5, with small clusters of yellow cells $c\ c'$.

FIG. 8. Enlarged view of tubes of the vascular system of the keel, to show the mode of ramification and anastomosis over the surface of the keel.

FIG. 10. (See Fig. 2.)

FIG. 11. General appearance of the net-work and principal branches of the so-called liver system $l\ l'$, under the conical part of the float *a*; seen in profile.

FIG. 12. General view of the ramifications of the same system, extending under the float; seen from above.

FIG. 13. Branch of liver system and anastomoses at the junction of the float and of the horizontal mantle.

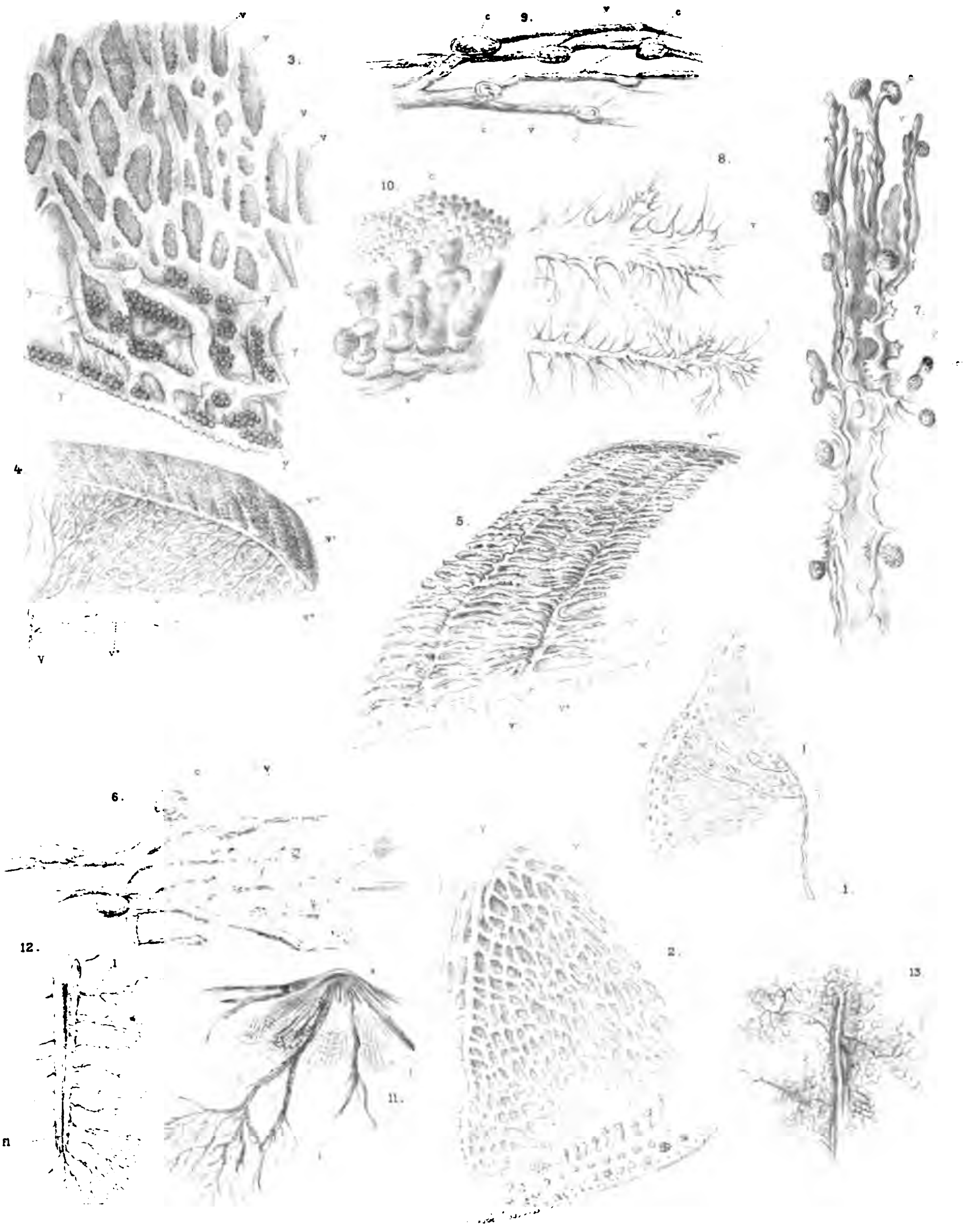

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PLATE VI.

FIG. 1. Young Velella seen in profile, measuring about $\frac{3}{16}$ of an inch in length: *c*, central chamber; *l*, central part of the liver in the conical part of the float; *f*, flexible keel formed by the free edge of the mantle; *cp*, central feeding polypite; *t*, prehensile tentacles; *fp*, small feeding polypites.

FIG. 2. Same seen from the lower side, with single ramifications of the liver system extending to the edge of the horizontal mantle.

FIG. 3. Somewhat younger than the preceding stage. The ramifications of the liver system are less pronounced; the central feeding polypite is not expanded as in the other stages.

FIG. 4. One of the large blue prehensile marginal tentacles, *t*, of the preceding figure.

FIGS. 5, 6, 7. Different stages of growth of the small feeding polypites of Fig. 3.

FIG. 8. Smallest Velella found at the Tortugas, with a hood-like free mantle, with only four chambers, a conical float, much like that of Pl. III, Fig. 1, in shape, surmounted by a flexible flat elliptical crest, with a large central polypite, eight large prehensile marginal tentacles, and the same number of small rudimentary feeding polypites.

FIG. 9. The same as Fig. 8, seen from above, showing the simple tubes of the liver system of that stage.

FIG. 10. Central polypite of a large Velella slightly drawn in.

FIG. 11. Different attitude of the same.

FIG. 12. Basal part of the same when fully expanded.

FIG. 13. Distal extremity of the same when fully extended.

FIG. 14. Terminal part of one of the prehensile tentacles, showing the band of lasso-cells running along the edges.

FIG. 15. Somewhat more magnified view of a part of such a tentacle, showing the terminal band of lasso-cells.

FIG. 16. Part of the base of a prehensile tentacle where the band of lasso-cells becomes broken up in patches.

FIG. 17. One of the prehensile tentacles showing the passage of the terminal band of lasso-cells into patches near the base.

FIG. 18. Young prehensile tentacle, with large patches of lasso-cells, but without a terminal band.

FIG. 19. Portion of proliferous polypite with young medusæ buds *m*, and the extremity of the tubule *t*.

FIGS. 20, 21. Ramifications of the vascular system at the base of the feeding polypites on the mantle of the lower side of the float.

FIG. 22. Enlarged view of the central feeding polypite of an adult Velella, showing the rudimentary lips of the actinal opening and the longitudinal rows of patches of lasso-cells *b*.

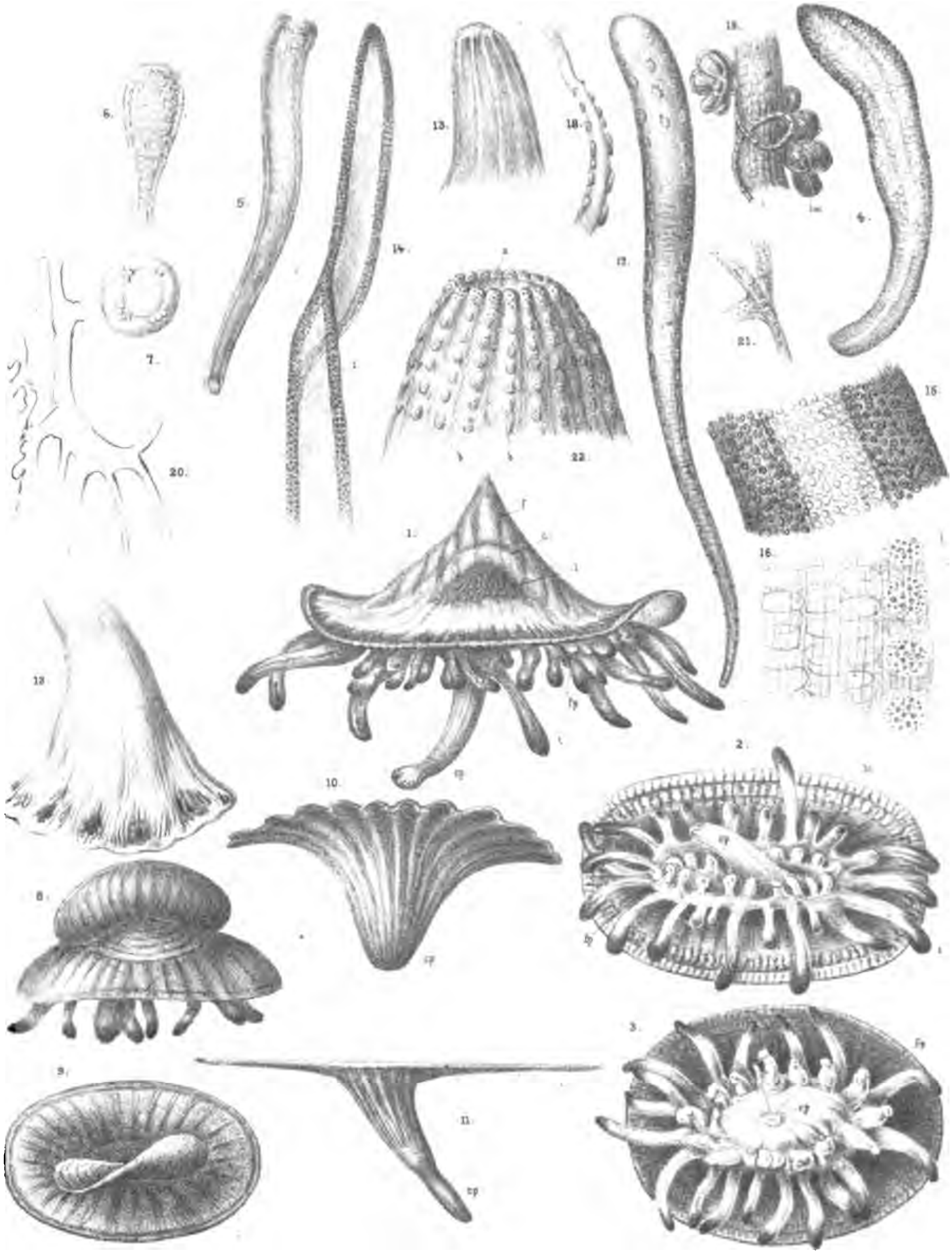

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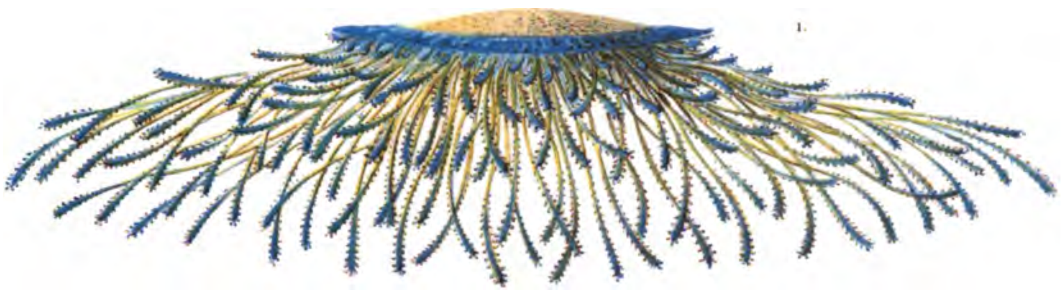
PLATE VII.

Fig. 1. Porpita seen in profile fully expanded, $1\frac{1}{8}''$ in diameter.
Fig. 2. The same seen from the upper side of the float.

Pl VII

1.



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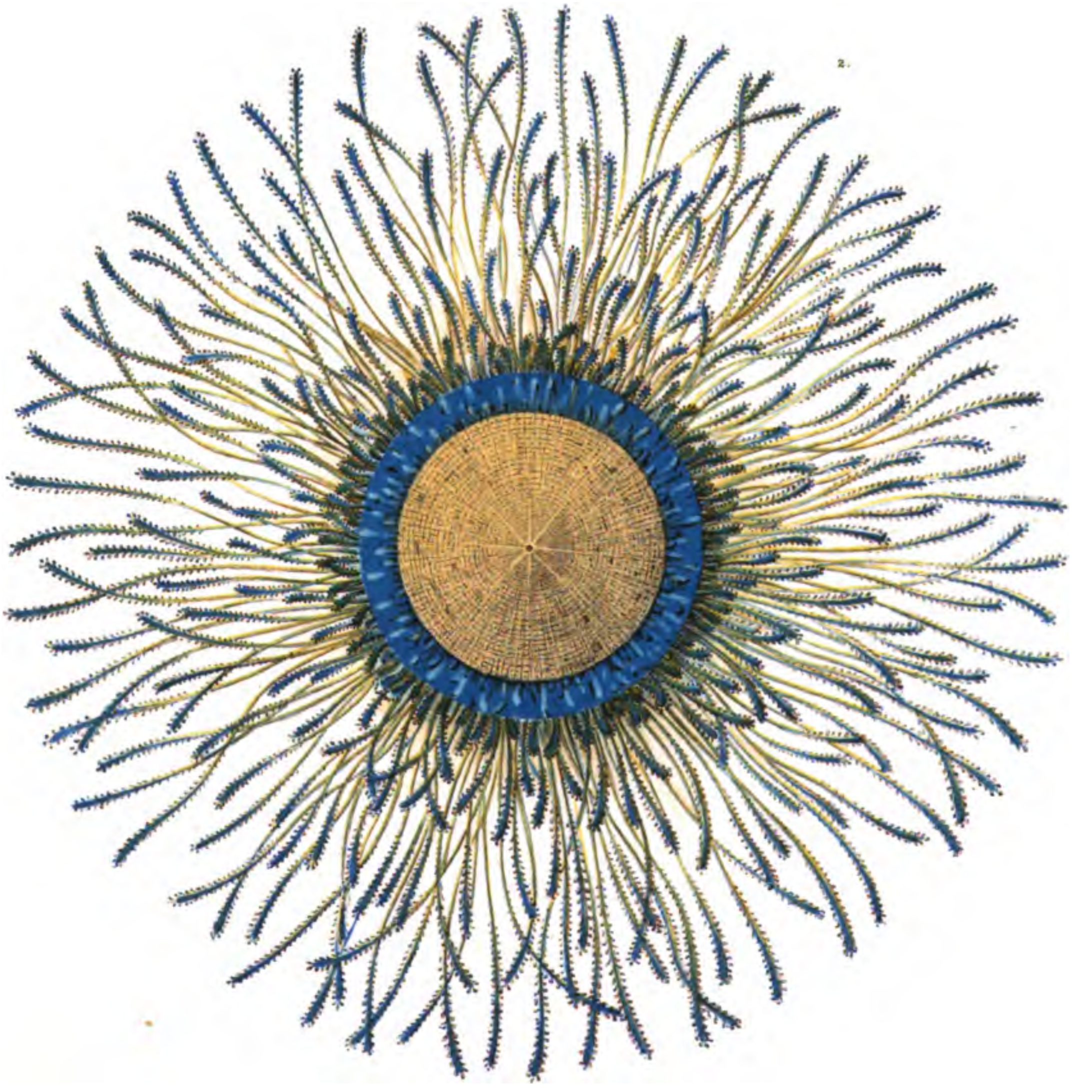

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PLATE VIII.

FIG. 1. A portion of the disk of a Porpita, showing the white plate with its spongy ramifications *i*, extending into the base of the feeding and reproductive polypites (*c p*, *f p*), with the so-called liver *l*, placed between the lower floor of the chambers of the float *c*, and the spongy upper part of the white plate; with the tubules *t*, extending from the lower side of the float through the mass of the liver, many of them passing through the white plate and extending along the base of the feeding and reproductive polypites.

FIG. 1ª. General view showing the relative position of the white plate *i*, the liver *l*, the chambers of the float *c*, and of the tubules of the upper and lower side of the plate.

FIG. 2. A cluster of feeding and reproductive polypites: *t*, tubules extending along the base; *m*, medusæ buds in different stages of development.

FIG. 3. A single reproductive polypite with two very young medusæ buds *b b*.

FIG. 3ª. Actinal opening of one of the feeding polypites.

FIG. 4. A single reproductive polypite with clusters of medusæ *m*, in different stages of development and the tubule *t*, extending more than half the length of the polypite towards its extremity.

FIG. 5. Different view of a single reproductive polypite, with two clusters of medusæ.

FIG. 6. Young medusa just freed from the reproductive polypite: *d*, canal leading to the cavity of the polypite through the base of attachment; *y*, clusters of yellow cells; *c*, large lasso-cells.

FIG. 7. Young medusa, somewhat older, more elongate, lettering as in the previous figure. The lasso-cells extend along the sides of the bell.

FIG. 8. Young medusa, stage intermediate between Figs. 6 and 7.

FIG. 9. Same seen from above.

FIG. 10. Fig. 6 seen from above.

FIG. 11. Fig. 7 seen from above.

FIG. 12. Abactinal part of the bell of Fig. 7: *c h*, chymiferous tubes; *d*, rudimentary digestive cavity.

FIG. 13. Portion of the edge of the bell of a medusa in the stage of Fig. 7, lettering as before.

FIG. 14. One of the large lasso-cells of the surface of the bell with the coil partially thrown out.

FIG. 15. Young medusa still attached to the reproductive polypite.

FIG. 16. A portion of the free edge of the mantle: *d*, edge of the disk; *g*, one of the marginal glands.

FIG. 16ª. View from the lower side of the disk, to show a portion of the ramifications of the liver.

FIG. 17. Fatty globules filling the marginal glands.

PLATE IX.

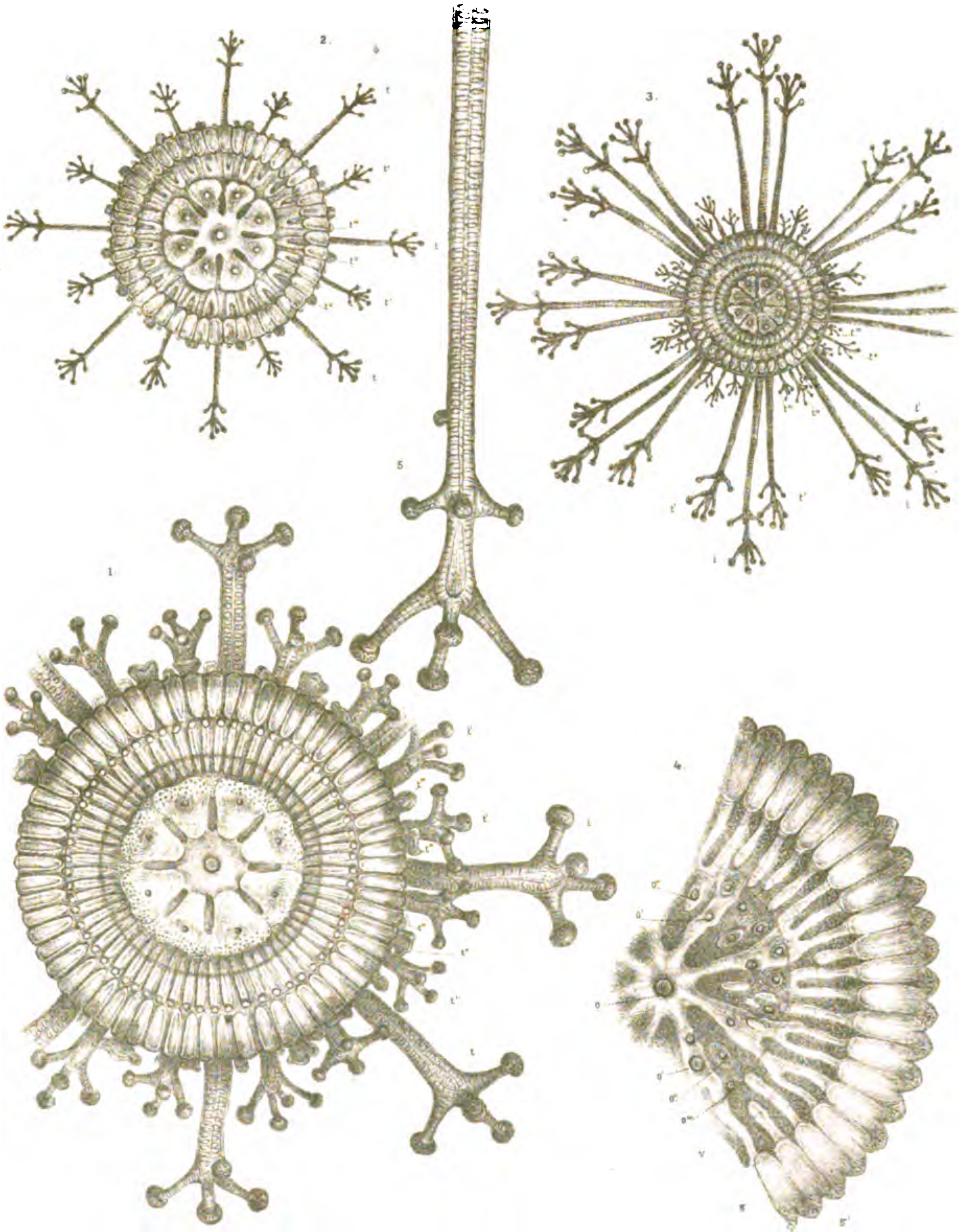
FIG. 1. Young Porpita with the eight primary chambers, surrounded by simple straight vascular canals with eight large primary four-knobbed marginal tentacles t, sixteen secondary tentacles t', of about half the length of the first set, and a third set of still smaller tentacles t'', from thirty to fifty in number, alternating between them and scarcely projecting beyond the margin of the disk. The disk measures only $\frac{1}{32}''$ in diameter.

FIG. 2. A somewhat older stage, the disk measuring about $\frac{1}{3}$ more in diameter than the preceding stage. The tentacles have greatly increased in length and are proportionally more slender; the primary and secondary tentacles also have two coils of tentacular knobs.

Fig. 3. Still older stage, the primary chambers occupy a comparatively smaller area of the disk; the secondary tentacles, t', are nearly as long and slender as the eight primary ones, t; and the third set of tentacles, t'', have also developed tentacular knobs.

Fig. 4. Ramifications of the vascular system in an older stage than the preceding, in which the eight primary chambers, with their openings o', are now surrounded by irregular circles of openings, o'', o''', leading to the second and third concentric chambers of the disk.

Fig. 5. Extremity of the primary tentacle of a young Porpita, in the stage of Fig. 2.



P. Roetter, lith. A. Ag. del. Printed by A. Meisel.

PLATE X.

Fig. 1. Profile view of a large Porpita measuring $1\frac{1}{16}''$ in diameter, with the tentacles swung under the disk and the disk thrown up.

Fig. 2. Disk seen from above to show the arrangement of the tentacles of a young Porpita, measuring about $\frac{1}{2}''$ in diameter.

Fig. 3. Magnified portion of a part of the disk of Fig. 2, and of the corresponding marginal tentacles ; *pp*, proliferous polypites.

Fig. 4. Portion of the lower side showing the mouth of the central polypite *m*, and the rows of reproductive polypites *pp*, with the tubules *tt*, extending over the base of the central polypite.

Fig. 5. Magnified view of a portion of the disk showing the central polypite *cp*, fully expanded, with the rows of reproductive polypites *pp*, between the base of the central polypite and the marginal tentacular polypites *tp*.

Fig. 6. Magnified view of a small reproductive feeding polypite *pp*, with a cluster of medusæ in different stages of development, and with the meandering tubules extending over its base.

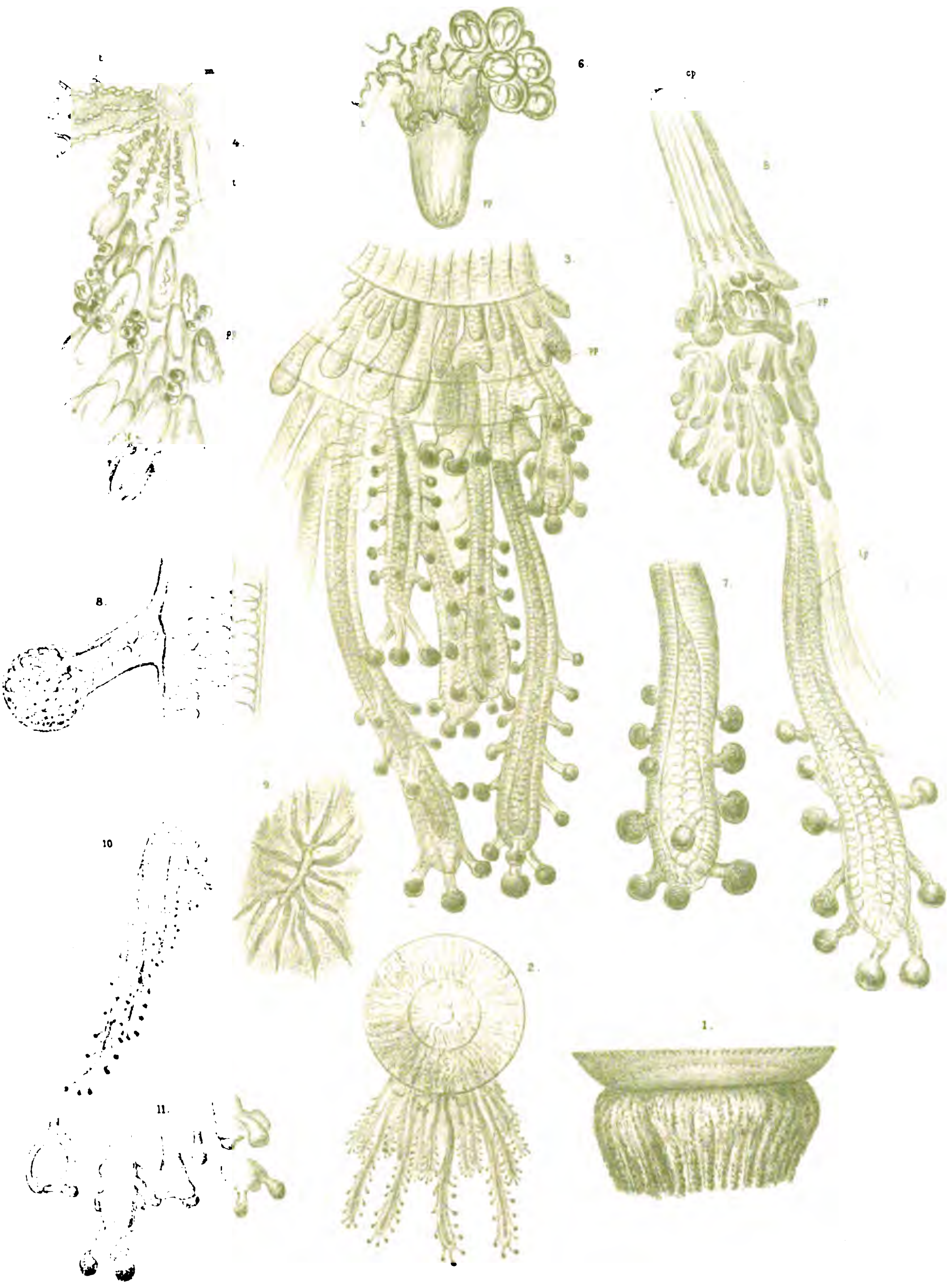
Fig. 7. Extremity of one of the largest marginal tentacular polypites, showing the arrangement of the tentacular knobs.

Fig. 8. Magnified view of one of the tentacular knobs.

Fig. 9. Folds of the actinal opening of the central polypite.

Fig. 10. Profile view, showing the arrangement of the tentacular marginal polypites.

Fig. 11. Different stages of growth of the smaller marginal tentacular polypites.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11.

PLATE XI.

Fig. 1. Portion of the lower side of the disk, showing a part of the white plate *ss*, with the ramifications of the liver *ll*, and the course of the tubules *tt*, which have passed through the white plate, with portions of the corrugations of the lower side of the circular chambers *c*.

Fig. 2. Diagrammatic sketch showing the relative position of the disk, of the edge of the white plate, and of the mantle.

Fig. 3. Central chamber *a*, with the adjoining chambers from which lead the first rows of tubules *t*.

Fig. 4. Cluster of tubules on the dorsal side of the white plate.

Fig. 5. Corrugations of three of the inner chambers of the lower side of the disk, showing the short tubules and their mode of attachment, about under the white plate.

Figs. 6, 6′. Greatly enlarged view of a few joints of one of the tubules.

Fig. 7. Part of the outer portion of the disk, showing the arrangement of the stigmata *o*, on the upper surface.

Fig. 8. Slightly oblique view of the cross-section of the outer part of the disk showing the position of the stigmata *oo*, of the successive chambers *aa*, and of the primary and secondary corrugations on the lower side, *c* and *c′*, of the circular chambers, and the mode of attachment of the tubules *tt*.

Fig. 9. Different profile view of a portion of the disk. Lettering as before.

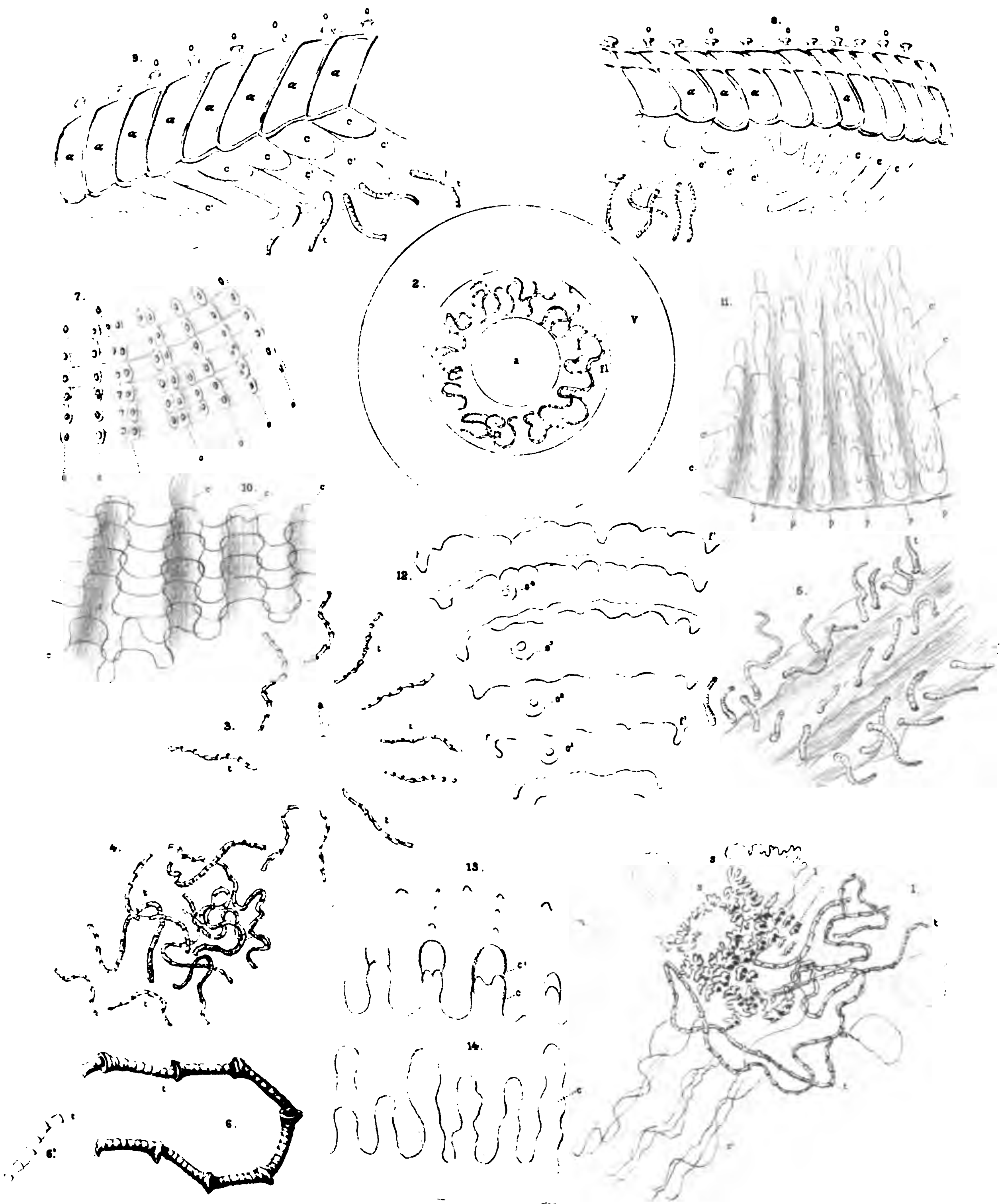
Fig. 10. Shows the general arrangement of the simple corrugations, *c*, of the lower side of the circular chambers, in a young specimen.

Fig. 11. Portion of the lower side of the disk showing the folds of the lower side of the chambers, *c c′*, as older far as the last outer circular wall, *ppp*, of the disk.

Fig. 12. Portion of the disk of a young Porpita, $\frac{3}{32}''$ in diameter, with four circular chambers; o'–o^4, stigmata, *ff′*, fold in the chambers corresponding to the original eight chambers, and forming in older specimens the irregularly radiating lines of the upper side of the disk.

Fig. 13. Slightly oblique end view of a part of the corrugations, *c c′*, of the last chamber of the edge of the disk.

Fig. 14. An end view of a few corrugations of a similar part of the disk.



F. Roetter lith. A. Ag. del. Printed by A. Meisel

PLATE XII.

Fig. 1. Portion of the disk of a young Porpita, measuring over $\frac{1}{16}''$ in diameter, seen from the upper side.

Fig. 2. Same seen from the lower side.

Fig. 3. Portion of the disk of a young Porpita, measuring $\frac{3}{32}''$ in diameter.

Fig. 4. Young Porpita, measuring $\frac{3}{16}''$ in diameter, in which a portion of the disk of the vascular system has remained simple. Seen from above.

Fig. 5. Portion of the disk of a young Porpita, nearly in stage of Fig. 4, seen from above, but the vascular system is branching.

Fig. 6. Portion of the disk of a young Porpita at about the same stage with simple vascular system, but proportionally longer tubes.

Fig. 7. Portion of the disk of a young Porpita about in stage of Fig. 6, seen from the lower side of the disk.

FIG. 8. Portion of the disk of a young Porpita somewhat more advanced, the vascular system more branching.

FIGS. 9, 9′. Portion of the disk of a young Porpita measuring about $\frac{1}{4}''$ in diameter. The ramifications of the vascular system are limited to the margin of the mantle.

FIG. 10. Portion of the disk of a young Porpita measuring $\frac{5}{32}''$ in diameter.

FIG. 11. Portion of the disk of a Porpita measuring not quite $\frac{1}{2}''$ in diameter.

FIG. 12. Marginal folds of the edge of the mantle.

FIG. 13. Portion of the disk of a Porpita measuring 1″ in diameter, showing the system of anastomosing tubes of the mantle.

FIG. 14. A portion of the same, showing the star-like irregular termination of this anastomosing system.

FIG. 15. Magnified view of a part of the white plate.